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Corona Treated Hybrid Nanocomposite Textile Fiber

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ABSTRACT

- Fabrication and Characterization of corona treated hybrid nanocomposite fibers by solution spinning process
- Characterization study differential scanning calorimetry (DSC), scanning electronic microscopy (SEM), and thermogravimetric analysis (TGA).
- Differential Scanning Calorimetry (DSC) study showed increased crystallinity in the hybrid fibers due to the inclusion of 7-wt% PVDF in PAN
- A significant improvement in thermal stability of PAN-PVDF-SWCNT fibers compared to neat fibers are also observed in TG study

INTRODUCTION AND MOTIVATION

- Plasma treated nanocomposite textile fiber offers the possibility of better morphological and piezoelectric property by shifting PVDF crystalline phase from α to β.
- PVDF has good mechanical properties and high piezoelectricity
- The PVDF film is used extensively in application of strain sensors, mechanical actuators, energy harvesters and artificial muscles.
- PVDF fibers are sensitive to small forces through pressure, mechanical vibration, elongation or compression, and bending or twisting.

FUTURE WORK

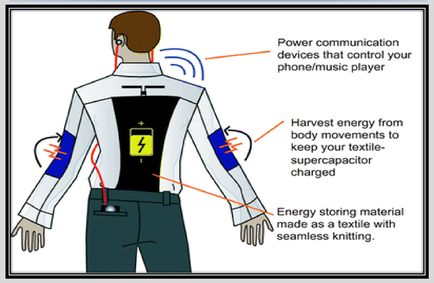
- Tensile testing of corona treated fibers will be performed to determine the mechanical properties.
- An impact test rig will be performed to observe the generation of voltage upon application of an impact load using a digital oscilloscope.
- Fourier Transform Infrared Spectroscopy (FTIR) will be done on fibers to analyze the effect of corona application.

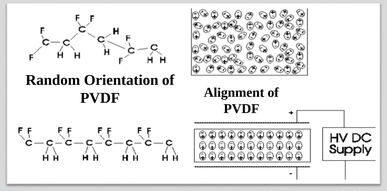
MATERIALS AND METHOD

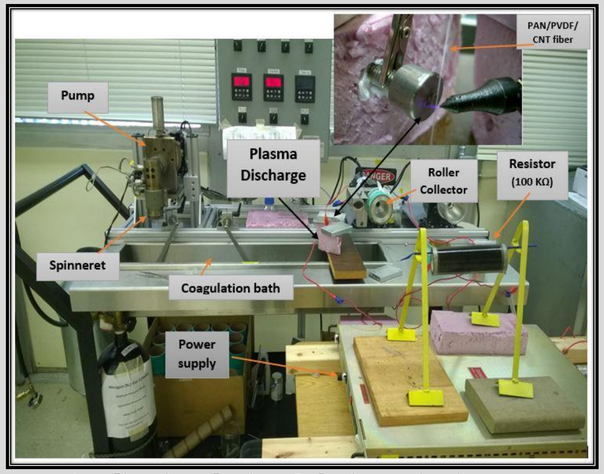
Process:

- 1.8 wt.% SWCNT was sonicated for 1 hour with DMF.
- 14 wt.% PAN (avg. mw 150,000) and PVDF (avg. mw 534,000) were added one by one at 80°C.
- First, PAN was dissolved completely with overhead stirrer then PVDF was added and mixed properly.
- A lab scale solution spinning unit was used to fabricate the Nano- fiber via wet and dry-wet spinning with a controlled temperature.
- The as-produced viscous gel-like solution was pumped through a spinneret to a coagulation bath
- After the formation of fibers, plasma was applied immediately and the fibers were collected to a take-up roller at a draw ratio of 1:5.
- The collected fiber was dried and Vacuum for 7-8 hour with drier and vacuum oven

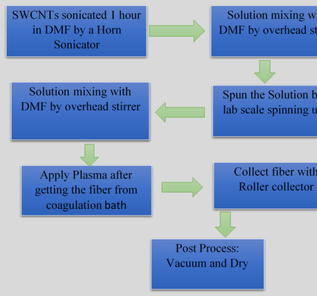
Application of Piezoelectric Textile Fibers



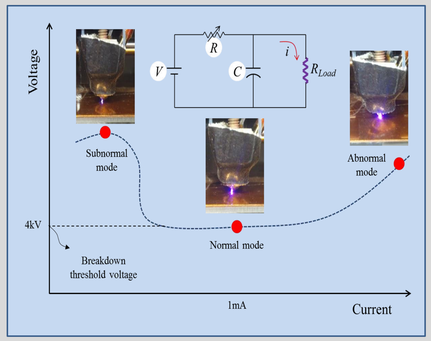


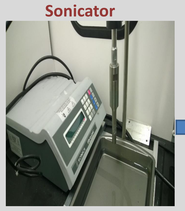


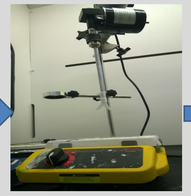
Corona Application during Solution spinning process

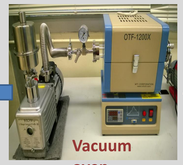


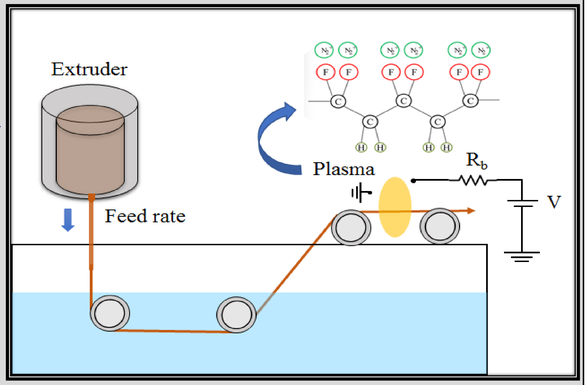
Different State of Plasma





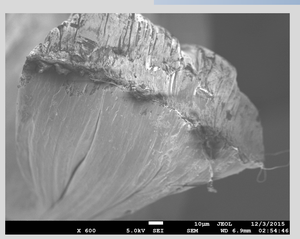




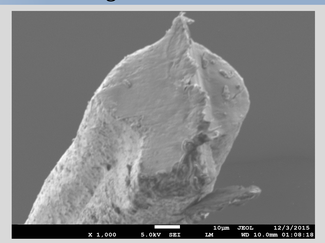


RESULTS

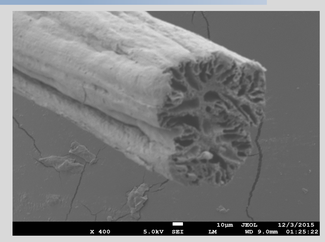
SEM Images PVDF with CNT and PAN fibers



PVDF + CNT



PAN + PVDF

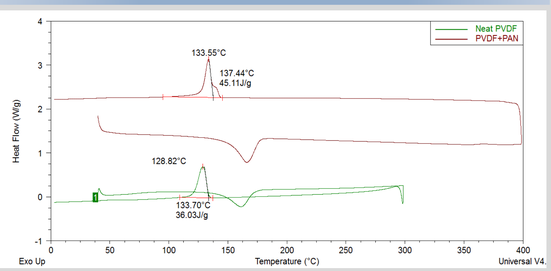


PAN+PVDF+CNT fiber

Stable Corona glow Operating conditions

- Discharge current: **0.11 mA**
- Discharge voltage: **3.8 kV**

DSC of neat PVDF and PVDF+PAN



- Plasma application setup consists of a high voltage power supply, a ballast resistor, anode and cathode.
- Corona and normal glow plasma were generated by altering voltage, current and the distance between anode and cathode

DSC of Dif020nt PVDF+PAN+CNT fibers

Type	Enthalpy (J/g)	Percent crystallinity (%)	Tp Crystallization Point (C)
PVDF	36.03	59.34	133.70
Plasma Treated PVDF	44.80	42.67	134.12
PAN+PVDF	45.11	76.40	137.44
PVDF+CNT	34.75	33.09	135.75
PAN+PVDF +CNT	579.9	552.3	306.33

- Longitudinal views of outer surface of PAN/PVDF/SWCNT fibers showed no indication of surface defects or protrusions.
- The cross-section of PAN+PVDF or PVD+CNT was almost smooth but the cross-section of PVDF+PAN+CNT had hollow inside.
- Differential Scanning Calorimetry (DSC) study shows increased crystallinity in the hybrid fibers due to the inclusion of 7 wt.% PVDF
- A significant improvement in thermal stability of PAN-PVDF-SWCNT fibers compared to neat fibers was observed in TGA study